CLASSIFICATION CONFIDENTIAL

CENTRAL INTELLIGENCE AGENCY
INFORMATION FROM
FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT
CD NO.

50X1-HUM

COUNTRY	USSR	DATE OF INFORMATION	1947
SUBJECT	Scientific - Microphotography		
HOW PUBLISHED	Bimonthly periodical	DATE DIST.	29 Apr 1949
WHERE PUBLISHED	Moscow	NO. OF PAGES	5
DATE PUBLISHED	Jan - Feb 1948		
LANGUAGE	Russian	SUPPLEMENT TO REPORT NO.	

THIS IS UNEVALUATED INFORMATION

SOURCE   Kolloidnyy Zhurnal, Vol 10, No 1, 1948, (FDB Per Abs 46T95).

MICROMEASUREMENT OF SIZES OF DUST PARTICLES

Yu. O. Kan'ko
NIOGAZ Laboratories
17 March 1947

Using the field of a microscope to compute the sizes of dust particles is convenient in determining their extreme sizes, i. e., the largest and the smallest. The difficulty encountered in using a sufficiently large quantity of particles in order to obtain an average, prevents the use of this method on specimens of heavier dust which are polydispersed in composition. In these cases, to justify the law of large numbers, the measured amount of particles must constitute a definite part of the weight of the specimen examined.

The work is facilitated and the accuracy of measurement is increased by the use of microphotography. On a photographic plate, a large number of fields can be taken, which after enlargement can be quite simply and quickly measured. A reticulated ocular micrometer is fitted on the lens of a camera, attached to a microscope tube, by means of a carefully adjusted collar. The number of gradations on the micrometer is determined in advance by means of an object micrometer. Thus, we immediately get, on the negative, pictures of the grains distributed on the screen; moreover, transference of the negative to a reticulated screen, or rephotographing to plot the screen on the negative, is avoided. It is possible to do without photography if the pictures of the field are reflected, by means of a double refraction prism, on a screen on which measurements of the sizes of particles can be made, as in enlarged photographs.

These methods make it possible to enlarge pictures of particles in the field of the microscope, at least 20,000 times, and permit rapid and exact measurements, by the use of an ordinary millimeter scale. But, whether the measurements are made directly in the field of the microscope, or by microphotography, in all cases they are made by the visual projection of the particles. Thereby, systematic error is introduced in determining the average size of the particles, since most dust particles, being three-dimensional bodies, lie on a plane surface because of the large projection.

CLASSIFICATION CONFIDENTIAL

STATE	X	NAVY	X	NSRB		DISTRIBUTION					
ARMY	X	AIR	X	FBI							

Furthermore, determination of the third dimension of the particles has, in addition to its general importance, a very great value in correctly determining the hydraulic size and specific surface of the particles, which play an essential role in the problems of filtering gases and liquids that carry hard particles of matter suspended in them.

The purpose of the present article is to demonstrate the possibility of a sufficiently accurate and objective determination of the sizes of fine particles of solid matter in three dimensions.

In petrography there is a method for exact determination of the thickness of a section according to the interference color of the minerals. Another simpler but less exact method is measuring by the difference in the pitch of the micrometer screw in focusing the microscope on the upper and lower surfaces of the cross section. Our problem, using the simpler principle as a basis, is to increase accuracy in determining the third dimension of micro-objects by making use of a stereoptical effect. With micro-observed objects that are sufficiently large in relation to the length of a light wave, the effect depends on their distance from the anterior focal plane of the lens along a visual beam.

Calculations demonstrate that, in principle, there are no difficulties in devising a method for such measurements.

In stereophotography it is not necessary to make any direct measurements of the object. It is enough to have two photographs of it, taken from two different points, the distance between which, called the base, is known.

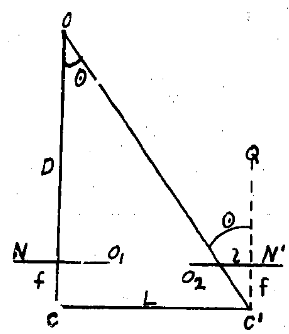

Figure 1

Figure 1 shows how the position of a point of an object in the plane, called normal in a particular case, can be determined on the basis of stereophotometric data. This case, which is basic for us, is characterized by the coincidence with the center of the photograph, of the base of a perpendicular, dropped from the optical center of the system to the surface of the photograph. For the beginning of the coordinate system, a point to the left on the base C is selected; the other end of the base is placed at the point C_1--the second point for the camera to stand. Thus: L is the base length; O_1 is the image of the point O on the left-hand negative; O_2 the image of O on the right-hand negative; $O_1C = f$, the distance to the image in the camera; COC_1 is the angle of parallax; D, - the unknown distance of the point O to the base, may be determined, as may be seen from the figure, from the ratio:

50X1-HUM

CONFIDENTIAL

$$D : L = f : l,$$

whence

$$D = Lf/l. \qquad (1)$$

Here L and f are constants, and l is the linear parallax measured on the negatives.

In employing equation (1) it is necessary to place the magnitude D at an equal distance, by optical beam, between the focus located on the plane passing through the base of the particle to be measured and the focus in the plane carried parallel to the first through the top of the same particle. Hence, the deduced ratio (1) shows that measurement of the depth of microobjects, in a vertical direction, can be replaced by measurement of the linear dimensions on the plane of their images.

It should be pointed out that, because of the great magnification afforded by the microscope, the stereoscopic effect is greatly increased. This is evident from the following simple calculation. If the distance between the centers of the eyes, the "optical" base is denoted by b; the distance from a point to the base in a perpendicular direction, by r; and the angle of parallax by α, we may assume that

$$r = \frac{b}{\alpha}. \qquad (2)$$

The size of the angle of parallax α is usually expressed by the least angle γ at which the eye distinguishes two noncoincident points, when expression (2) takes the form $\frac{b}{\gamma \sin 1''}$. Because of enlargement by the microscope, the size of the angle γ is diminished; if K is the magnification of the microscope,

$$r = \frac{b}{\frac{\gamma}{K} \sin 1''} = \frac{kb}{\gamma \sin 1''}$$

the stereoscopic effect is increased k times.

For our purposes there is no need for the value of the outer coordinates and therefore there is no question of error in the outer orientation which is essential, for instance, in geodesy. On the other hand, error in the inner orientation, the determination of the size f in particular, is of the greatest importance. Consequently, it is necessary for the microcamera to be adjusted to a mechanical ratio so that the plate is held straight and very close to the frame. Dust or dirt in the gaps must be eliminated so that the focal length of the camera will not be altered because of abrupt changes in temperature--conditions which are hard to obtain in field work but may usually be obtained in laboratories.

By differentiating expression (1), it is possible to determine the effect on calculation of the amount of distance produced by error in determining the size l:

$$dD = \frac{Lf}{l^2}\, dl; \qquad (3)$$

if $l = \frac{Lf}{D}$ be substituted,

$$dD = \frac{D^2}{Lf}\, dl. \qquad (4)$$

CONFIDENTIAL

Sanitized Copy Approved for Release 2011/06/28 : CIA-RDP80-00809A000600220578-7

It follows from equations (3) and (4) that the error in determining the third dimension of the object is proportional to the square of the distance and in inverse proportion to l^2.

This factor is very important in aerial photography, since it limits the altitude. But in our case the probability of error is insignificant since it is determined by the distance of the object from the lens of the microscope and is expressed by a few millimeters for weak lenses and fractions of a millimeter for strong lenses.

If L is considered to be a variable, by differentiating (1) and using the same substitution, we shall find the relation of the error in D to the dimension of the base to be:

$$dD = \frac{D}{L} dL$$

or

$$\frac{dD}{D} = \frac{dL}{L}. \qquad (5)$$

It is evident from equation (5) that the relative error in determining the thickness is in inverse proportion to the dimension of the base.

We determined the dimension of the base by displacement of the microscope slides and found it to be less than 2 millimeters in all cases.

Enlargement of the base during micromeasurements was limited by the construction of the microphotographic apparatus and by the spherical aberration of the lenses of the microscope.

In ordinary (horizontal) measurements of the sizes of particles, the boundaries of the field were likewise limited by the dimensions of the screen or scale, that is, to 2 millimeters. Hence the problem of accuracy in determining sizes in a vertical direction loses its specific meaning and is connected with the general problem of the accuracy of measurements under the microscope in the visual field. These measurements depend on the technical equipment and, at present, can be brought to a satisfactory degree of accuracy.

Experiments in Volumetric Micromeasurement of Dust Particles

The construction of a microscope permits adjusting its stage so that it will be absolutely perpendicular to the tube. To obtain stereomicrophotograms, use is made of a special microscope with two tubes. It is, however, possible to work with a simple microscope. In the latter case one of the methods described is used.

The position of the object on the stage remains fixed. For stereophotography use is made, first, of one half of the lens and then of the other half. There is inserted between the lens and the end of the tube an additional device, in the form of a semicircular diaphragm, by means of which first one half and then the other half of the lens is opened to admit the light rays. Each stereophotograph is made on two separate 9 x 12 plates or on the two halves of a 13 x 18 plate. In this case the unilluminated half of the plate is covered by a piece of cardboard.

Another method of stereophotography consists in moving the lens either separately or with the camera.

The third method we employed consisted in moving the object by the

50X1-HUM

CONFIDENTIAL

means of slides. The distance the slides were moved was determined by gradations on them, by means of a vernier, accurate to 1/100 millimeter. This distance was the base and it did not exceed 1.5 millimeter. Measurements were made in the following manner. An image of the microscope field was reflected on a screen, producing a 36,000-power enlargement. This also includes the microscope magnification factor. The coordinates of the extreme points of each particle, which determine its size in relation to the central point of the grid reflected on this same screen, were measured by a slide gauge accurate to 0.1 millimeter. Then the slides were moved and the same measurements were made in relation to the same beginning of the coordinates with the new position of the particles. Differences between the coordinates of corresponding points were calculated according to these data. Under all conditions these measurements were the most accurate obtained by any existing method for determining the sizes of particles of a solid substance.

Average Sizes of Dust Particles Calculated From Data on Horizontal and Volumetric Measurements

Ordinary Measurements	With Thickness Calculated	Ordinary Measurements	With Thickness Calculated
58.5	47.	4.5	3.2
100.	83.3	3.0	2.4
46.	39.	6.5	5.
127.	65.6	9.5	6.2
45.75	23.8	5.5	4.2
10.35	7.6	8	5.5
62.25	54.8	6.8	3.7
244.0	181.	9.5	8.
105.	87.	47.5	37.3
81.5	65.	262.7	201.5

The table gives the average sizes of the same particles calculated according to data on horizontal and volumetric measurements. The material was taken from dust samples obtained from Underground Gas Well 48 (Podzemgaz), containing, in addition to coal particles, up to 87 percent rock particles.

The data in columns 1 and 3 were calculated as an arithmetical mean of two measurements on the surface of the pictures: the greatest distance between the two extreme points and the distance between two other points in a perpendicular direction. The data in columns 2 and 4 were calculated as an average of three dimensions, the third of which was determined by the stereometric method described above. From the data in the table it may be seen how much error is allowed by the ordinary planar method of measuring the sizes of dust particles.

Conclusions

1. Volumetric or stereometric measurement of the sizes of dust particles under the microscope permits the most accurate determination of their sizes, since the systematic error in determining the size of particles by planar projection is eliminated.

2. Mathematical analysis of errors possible in the volumetric measurement of dust particles shows that, because of the insignificant distance between the object and the microscope lens, and also because of the great magnification afforded by the latter, the errors relative to the small size of the base and the linear parallax are negligible.

3. The use of modern optical equipment and photographic apparatus permits measurements accurate to 0.1 μ of particles larger than 12 μ, [illegible] more accurately than has heretofore been possible.

- E N D -

CONFIDENTIAL

Sanitized Copy Approved for Release 2011/06/28 : CIA-RDP80-00809A000600220578-7